Financial Benefit- Cost Analysis

In the competitive economy, selection of the best investment project out of numerous alternatives or ranking them in order of economic and social profitability, is an upheaval task. Simply stated, a project would be most suitable if there is maximum difference between the stream of benefits and costs associated with various choices. In Layman's words, a project affording highest amount of benefits for the same cost or the same amount of benefits at the least cost, is deemed to be the best one. A project has therefore, to be judiciously, cautiously and intensively appraised by application of a host of quantitative techniques to identify, enumerate and measure costs/ benefits emanating from it.

Cost benefit analysis is one of the quantitative techniques which is very sophisticated. It attempts to find out most appropriate answers to the vexing problems especially in public sector projects. It facilitates to appraise and evaluate the desirability of incurring public expenditure in terms of social, economic, financial and ecological gains etc, to the society at large. As such, policy makers in public sector projects are not only required to supplement the basic financial appraisal as practiced by private entrepreneurs but also concern themselves to examine all the consequences with the stream of social value of benefits and costs associated with the project. The success of cost benefit analysis depends primarily on proper identification, enumeration and measurement of all project effects including intangibles. Sassone and Schaffer rightly observed CBA as an estimation and evaluation of net profits associated with alternatives for achieving defined public goals.

Cost benefit analysis is a financial technique that is specifically designed to predict the future worth of projects. Portraying all the positives and negatives, the cost benefit analysis technique helps in determining the depth of the project. To break the purpose of the cost benefit analysis, here are the two main reasons and purposes of the cost benefit analysis.

- To help in comparing projects in terms of total expected cost and expected benefits of each option, determining if the benefits outweigh the costs or not.
- To understand if the investment is sound, feasible, and justified.

- Provided these, the cost benefit analysis is used by governments, organizations, and most importantly business owners alike. The cost benefit analysis offers well educated estimates for the best alternatives.

The structure of a financial cost benefit analysis

1. Definition of project

   The reason for defining is that a project cannot be appraised unless what is to be appraised is known. This definitional step may also be used to determine the boundaries of analysis.

2. Compile lists

When running a cost benefit analysis is to compile a comprehensive list of all the costs and benefits associated with the potential action or decision.

Additionally, consider all the possible benefits of the course of action or decision - how much might it add to your revenue? What other benefits may be inherent in the action that would make it outweigh the costs? For example, would a new software improve efficiency or capabilities that could promote new business or make current operations run smoother?

4. Monetary valuation of relevant effects

In order for physical measures of impacts to be co measurable, they must be valued in common units. The common unit in CBA is money, whether dollar, pounds or yen. This is merely a device of convenience rather than an implicit statement that money is all that matters.

6. Discounting of cost and benefit flows

Once all relevant cost and befit flows that can be expressed in monetary amounts have been so expressed, it is necessary to convert them all into present value (PV) terms. This necessity arises out of the time value of money or time preference.

7. Applying the Net Present Value test

The main purpose of CBA help to select projects and policies which are efficient in terms of their use of resources. The criterion applied is the Net Present Value (NPV) test. This simply asks whether the sum of discounted gains exceeds the sum

of discounted losses. If so the project can be said to represent an efficient shift in resource allocation, given the data used in the CBA.

Example

The sale price of the fully-developed software is $200,000, and ABC company estimates an annual growth of 25% for the next five years. The costs of the software development include $75,200 upfront costs in year 0 and $29,000 ongoing costs for the next five years.

The company assumes a discount rate of 11% to estimate the discounted net cash flow. Using benefit cost analysis method check the financial viability of this project.

The cost benefit analysis as follows

Year	**0**	**1**	**2**	**3**	**4**	**5**
Benefits		200000	250000	312500	390625	488281
Cost-upfront	75200	0	0	0	0	0
Cost-ongoing	0	29000	29000	29000	29000	29000
Total cost	75200	29000	29000	29000	29000	29000
Net cash flow	75200	171000	221000	283500	361625	459281
Discount rate	11%					
Discount factor	1	0.9	0.81	0.73	0.65	0.59
Discounted net cash flow	75200	153900	179010	206955	235056	270975
	75200	1045896				
NPV	$ 970696					
IRR	(please calculate the IRR)					

The company decide that this project is financially viable because of its benefits exceeds the cost. Hence NPV is positive.

Advantages and Disadvantages of Cost Benefit Analysis

Advantages

1. Cost benefit analysis can be a helpful tool for businesses or individuals to undertake when considering a new course of action.
2. Running a CBA for a potential decision can help visualize the implications and impact of that course of action, and is often very helpful for smaller or medium-sized decisions that are more immediate in scope of time.
3. Compare different projects
4. Consider the time value of the money
5. Consider the whole cash flow of the project

Disadvantages

1. For bigger decisions with a longer time horizon, CBAs can sometimes fail to take into account other factors that might not be significant in the short term but would impact the long term, like inflation, interest rates and other larger, more long-term factors.

   Additionally, performing a CBA can often put projects or decisions in a purely numerical point of view, which may fail to take into account unforeseen events or circumstances that might affect the action.

2. A cost benefit analysis requires that all costs and benefits be identified and appropriately quantified. Unfortunately, human error often results in common cost benefit analysis errors such as accidentally omitting certain costs and benefits due to the inability to forecast indirect causal relationships. Additionally, the ambiguity and uncertainty involved in quantifying and assigning a monetary value to intangible items leads to an inaccurate cost benefit analysis. These two tendencies lead to inaccurate analyses, which can lead to increased risk and inefficient decision-making.

3. Increased subjectivity for intangible costs and benefits

Another disadvantage of the cost benefit analysis is the amount of subjectivity involved when identifying, quantifying, and estimating different costs and benefits.

Since some costs and benefits are non-monetary in nature, such as increases in customer and employee satisfaction, they often require one to subjectively assign a monetary value for purposes of weighing the total costs compared to overall financial benefits of a particular endeavor. This estimation and forecasting is often based on past experiences and expectations, which can often be biased. These subjective measures further result in an inaccurate and misleading cost benefit analysis.

4. Inaccurate calculations of present value resulting in misleading analyses

Since this evaluation method estimates the costs and benefits for a project over a period of time, it is necessary to calculate the present value. This equalizes all present and future costs and benefits by evaluating all items in terms of present-day values, which eliminates the need to account for inflation or speculative financial gains. Unfortunately, this poses a significant disadvantage because, even if one can accurately calculate the present value, there is no guarantee that the discount rate used in the calculation is realistic.

4. A cost benefit analysis might turn in to a project budget

Another disadvantage seen when utilizing a cost benefit analysis is the possibility that the evaluative mechanism turns in to a proposed budget. When a project manager puts together a cost benefit analysis and presents it to a leadership team, the leadership team might view the expected costs as actual rather than estimation, which may lead to misappropriating costs and setting unrealistic goals when approving and implementing a project budget. This can put a project manager in an unfavorable situation when he or she attempts to control costs in order to maintain the expected profit margin.

Benefit Cost Ratio (BRC)

BCR = Discounted value of benefits ÷ Discounted value of costs

Decision rule:

BCR> 1 Accept the project

BCR< 1 Reject the project

A BCR is an indicator, used in cost-benefit analysis, that attempts to summarize the overall value for money of a project or proposal. A BCR is the ratio of the benefits of a project or proposal, expressed in monetary terms, relative to its costs, also expressed in monetary terms. All benefits and costs should be expressed in discounted present values. A BCR can be a profitability index in for-profit contexts. A BCR takes into account the amount of monetary gain realized by performing a project versus the amount it costs to execute the project. If the projected revenue is more than the projected cost, the ratio is positive. The higher the BCR the better the investment. General rule of thumb is that if the benefit is higher than the cost the project is a good investment.

A BCR is an indicator used in cost-benefit analysis to show the relationship between the relative costs and benefits of a proposed project, expressed in monetary or qualitative terms. If a project has a BCR greater than 1, the project is expected to deliver a positive net present value to a firm and its investors. If a project's BCR is less than 1, the project's costs outweigh the benefits and it should not be considered.

Example

Assume company ABC wishes to assess the profitability of a project that involves renovating an apartment building that the company owns, over the next year. The company decides to lease the equipment needed for the project for $50,000, rather than purchasing it. The inflation rate is 2% and the renovations are expected to increase the company's annual profit by $100,000 for the next three years. According the BCR method check the profitability of investing in this project.

The NPV of the total cost of the lease does not need to be discounted, because the initial cost of $50,000 is paid up front.

The NPV of the projected benefits = $ 288388

$288,388= ($100,000 / (1 + 0.02)) + ($100,000 / (1 + 0.02)*2) + ($100,00 / (1 + 0.02)*3).

BCR = 288388/ 50000

= 5.77

In this example company has a BCR of 5.77, which indicates that the project's benefits significantly outweigh its costs. Moreover, company ABC could expect $5.77 in benefits for each $1 of costs.

Advantages of the Benefit Cost Ratio

1. It provides an added level of clarity.

The benefit cost ratio allows you to dive into the specifics of a project. You can see where your spending happens to be or where your cash inflows are happening. You must define these, then list the inflows and outflows of cash, to evaluate the project involved. Although there are always going to be unpredictable costs, there are usually unpredictable profits which occur as well, offsetting one another. That's why a BCR above 1 is considered a positive indication.

2. It creates a look at a project's overall feasibility.

Think of the benefit cost ratio as an "educated guess." If you've calculated your costs and benefits accurately, then you'll have a good idea of what the expected outcome should look like. The goal here is to be able to make a decision with greater confidence. The results are a forecast that, if all things go well, something successful is about to happen.

3. It provides a glimpse of current affordability.

With the benefit cost ratio, you can look at the various additional costs that will be required for a decision to proceed. You'll be able to know right away if your finances will be able to handle the added costs. Even if your BCR is positive, those costs could get in the way of your eventual success if more debt must be added to make that success happen. Knowing that you can afford the costs of a decision is a step in the right direction.

4. It can help provide insight into the unknown.

There are several different variables that may occur when the decision is made to pursue a project. Performing the calculations for the benefit cost ratio can help you find some of the potential variables that could affect your bottom line. If you were required to take out financing to cover costs, for example, then your interest rate on that debt could become a variable expense. By figuring out more of these variables,

you'll be able to create a BCR that is more accurate, which then leads you to a decision that is more confident.

5. It can develop beneficial policies.

Understanding the benefit cost ratio helps an organization, or a society, determine certain rules or regulations that should be followed. By understanding how benefits can be maximized, people can be encouraged to follow a certain path to make those benefits happen. That process further lessens the risk of the BCR being inaccurate.

Disadvantages of the Benefit Cost Ratio

1. It can lead to false confidence.

The primary limitation of the BCR is that it reduces a project to a simple number, when the success or failure of an investment or expansion relies on many factors and can be undermined by unforeseen events. Simply following a rule that above 1 means success and below 1 spells failure is misleading and can provide a false sense of comfort with a project.

2. It does not always factor in the indirect benefits.

There are several indirect benefits that a project creates which may not be reflected in the initial calculations of the benefit cost ratio. That is because the world is ever-changing and there are new ways of generating revenues which are hard to predicted. Your project might generate revenues through social media clicks or added brand awareness.

You might generate more loyalty within your targeted demographics by offering items or services with added value. Not every indirect value has a monetary assignment to it, which further complicates this calculation.

4. It may add more value to biased variables.

The value of the benefits (or the costs) is often determined by those who are closest to the project. Someone who is over-ambitious about a project might offer a value that is too high compared to what an outside observer might offer. On the other hand, the costs being presented for a calculation of the benefit cost ratio may be too low.

If either event occurs, the BCR will be inaccurate. To avoid this issue, never assume a discount will be offered. Always double-check anticipated revenues, costs, and benefits.

5. It may offer numerous unknown variables.

The unknown variables of a project can be so extensive that they invalidate the benefit cost ratio. Anything that is not considered, not known, or overlooked is classified as an unknown variable for BCR purposes. Most benefit cost ratio calculations will not have access to every exact benefit or cost figure.

External factors can become extreme and invalidate the calculations should they occur. Think about Hurricane Katrina. That is an extreme unknown variable that likely wiped out many BCR calculations.

6. It could be used to create moral decisions.

One of the greatest dangers of the benefit cost ratio is that it can be used to define morality. From a health standpoint, death has no measurable value. No one can transfer assets to someone after they die to restore their life. Those assets would only transfer to their estate. Trying to decide if a medical treatment is necessary, therefore, would place the value of a life at the cost of the procedure. Instead of weighing the pros and cons of that procedure, an effort should be made to save that life.

Sensitivity Analysis

The NPV test described above tells us about the relative efficiency of a given project, given the data input to the calculations. If this data changes then clearly the results of the NPV test will change too. But why should data be changed?

The main reason concerns uncertainty. In order to express the uncertainty quantitatively, we can include a sensitivity analysis into our cost benefit analysis. In the most common form of sensitivity analysis we change the input data could be changed in order to see what kind of impact such changes will have on the out put (NPV and IRR). Sensitivity analysis can be conducted changing the key input parameters (benefits, cost, discount rate etc..) of the project.

Based on the considerations following common question can be asked to do sensitivity analysis. However according to the nature of the project these question may change.

- What will happen if the gross revenue is reduced or increased by 25%?
- What will happen if the annual operational and maintenance cost is reduced or increase by 10%?
- What will happen if the investment is reduced or increased by 10%?
- What will happen if the compensation of affected parties reduced or increased by 25%?
- What will happen if all the four input data mentioned above are changed in the unfavorable direction at the same time?
- What will happen if the discount rate is reduced or increased by 3% to 7% or 15%?

This means recalculating NPV and IRR when the values of certain key parameters are changed.

When sensitivity analysis is conducted (i.e if we change one of the input variable of the project and recalculated the NPV and IRR), the percentage change of NPV and IRR can be calculated using following formula

Percentage change of NPV =

(NPV of sensitivity analysis- NPV of baseline) / NPV of baseline

Sensitivity of the output variable to input variable is calculate using following formula

$$\text{Sensitivity} = \frac{\%\ \text{change in output}}{\%\ \text{change in input}}$$

Sensitivity analysis allows identification of input variables that represent the greatest vulnerability for the project.

Advantages and disadvantages of the sensitivity analysis

1. They help in decision making. Sensitivity analysis is a method for predicting the outcome of a decision if a situation turns out to be different compared to the key predictions.
2. It helps in assessing the riskiness of a strategy.
3. Increased understanding of the relationships between input and output variables in a system or model.
4. Uncertainty reduction, through the identification of model inputs that cause significant uncertainty in the output and should therefore be the focus of attention in order to increase robustness (perhaps by further research).
5. Searching for errors in the model (by encountering unexpected relationships between inputs and outputs).
6. Model simplification – fixing model inputs that have no effect on the output, or identifying and removing redundant parts of the model structure.
7. In case of calibrating models with large number of parameters, a primary sensitivity test can ease the calibration stage by focusing on the sensitive parameters. Not knowing the sensitivity of parameters can result in time being uselessly spent on non-sensitive ones.
8. To seek to identify important connections between observations, model inputs, and predictions or forecasts, leading to the development of better models.

Example

A company is considering a project with initial costs of $500,000 involving purchase of new machinery with a useful life of 5 years. The after-tax cost of capital is 16%, and the marginal tax rate is 30%. The other key parameters of a project are presented in the table below.

	Year 1	Year 2	Year 3	Year 4	Year 5
Sales in units	20,000	22,000	27,000	25,500	23,000
Sales price per unit in US$	$35	$36	$38	$41	$45
Variable cost per unit in US$	$22	$22	$23	$25	$28
Fixed costs in US$	$100,000	$102,000	$105,000	$109,000	$115,000

The management of the company will conduct sensitivity analysis of the project to evaluate the financial viability of the project by considering risk and uncertainty of the project.

Management designates NPV and IRR as outputs. The inputs are:

- Fixed costs
- Sales in units
- Sales price per unit
- Variable costs per unit

For this purpose, sensitivity analysis is conducted changing following key parameters of the project.

1. Fixed costs will be 5% higher than baseline values
2. Sales units will be 5% higher than baseline values.
3. Sales price of a unit will be 5% higher than baseline values.
4. Variable costs per unit will be 5% higher than baseline values

Solution

Baseline case

Let's find the baseline NPV and IRR. The calculation of discounted cash flows is shown in the table below.

Variables	Year 1	Year 2	Year 3	Year 4	Year 5
Sales (s)	700000	792000	1026000	1045500	1035000
Total variable cost (TVC)	440000	484000	621000	637500	644000
Fixed cost (FC)	100000	102000	105000	109000	115000
Earnings before tax (EBT)	160000	206000	300000	299000	276000
Tax expense (T)	48000	61800	90000	89700	82800
Net income (NI)	112000	144200	210000	209300	193200
Discounted net cash flow(DNCF)	96551	107211	134615	115635	92000

The calculation of discounted net cash flow for designated Year 1 is shown below.

S =20,000 × $35 = $700,000

TVC = 20,000 × $22 = $440,000

EBT = $700,000 - $440,000 - $100,000 = $160,000

T = $160,000 × 30% = $48,000

NI = $160,000 - $48,000 = $112,000

$$DNCF = \frac{\$112,000}{(1+0.16)^1} = 96551$$

The discounted net cash flows in other designated years are calculated in the same manner.

The baseline net present value of a project is as follows:

Baseline NPV = -$500,000 + $96551+ $107211 + $134615 + $115635 + $92000 = $46012

The baseline IRR is

Sensitivity analysis 1

Let's assume that fixed costs will be 5% higher than baseline values. Provided other inputs remain constant, the discounted net cash flows will be as follows:

Variables	Year 1	Year 2	Year 3	Year 4	Year 5
Sales (s)	700000	792000	1026000	1045500	1035000
Total variable cost (TVC)	440000	484000	621000	637500	644000
Fixed cost (FC)	105000	107100	110250	114450	120750
Earnings before tax (EBT)	155000	200900	294750	293550	270250
Tax expense (T)	46500	60270	88425	88065	81075
Net income (NI)	108500	140630	206325	205485	189175
Discounted net cash flow(DNCF)	93534	104557	132259	113527	90083

NPV = -$500,000 + $93534+ $104557 + $132259 + $113527 + $90083 = $ 33960

Percentage change in NPV=33960-46012/46012= -0.26%

Sensitivity of NPV =-0.26%/5% = -0.052%

This means that with an increase in fixed costs of 1%, the NPV of a project will decrease by -0.052%.

(please complete the remaining part of the example)

Sensitivity analysis 2

Let's assume that sales in units will be 5% higher than baseline values. Provided other inputs remain constant, the discounted net cash flows will be as follows:

Variables	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Sales (s)	735000	831600	1077300	1097775	1086750
Total variable cost (TVC)	462000	508200	652050	669375	676200
Fixed cost (FC)	100000	102000	105000	109000	115000
Earnings before tax (EBT)	173000	221400	320250	319400	295550
Tax expense (T)	51900	66420	96075	95820	88665
Net income (NI)	121100	154980	224175	223580	206885
Discounted net cash flow(DNCF)					

NPV

IRR

Sensitivity analysis 3

Let's assume that the sales price of a unit will be 5% higher than baseline values.

Sensitivity analysis 4

Let's assume that variable costs per unit will be 5% higher than baseline values.